THE WEATHER AND CIRCULATION OF JULY 1950 [1]

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July 1950 was a remarkably cool, cloudy, and rainy month in the eastern three-quarters of the United States. In most areas from the Rocky Mountain States to the Atlantic Coast temperatures were below normal (Chart I), skies were clear less than half the time (Chart IV), and precipitation was excessive (Chart V and inset). These conditions were most marked in the southern and central Plains States, in portions of which the negative departure of mean temperature from normal exceeded 6° F., the percentage of clear sky between sunrise and sunset was less than 20, and total rainfall was more than 8 inches greater than the normal amount. Considering the extent and intensity of the below normal temperatures, this month was the coolest July of the last 25 years in the United States east of the Continental Divide and probably just as cool as any July of the past 40 years.

The principal feature of the general circulation with which this weather can be associated is a mean trough in the constant pressure surfaces located through the Mississippi Valley at all levels of the troposphere from 700 mb. to 300 mb. (Charts IX to XI). The field of 700-mb. height anomaly drawn in figure 1 shows that this trough was deeper than normal and displaced well to the west of its normal position, which is along the Atlantic Coast. As a

[1] See Charts I-XI, following p. 133, for analyzed climatological data for the month.

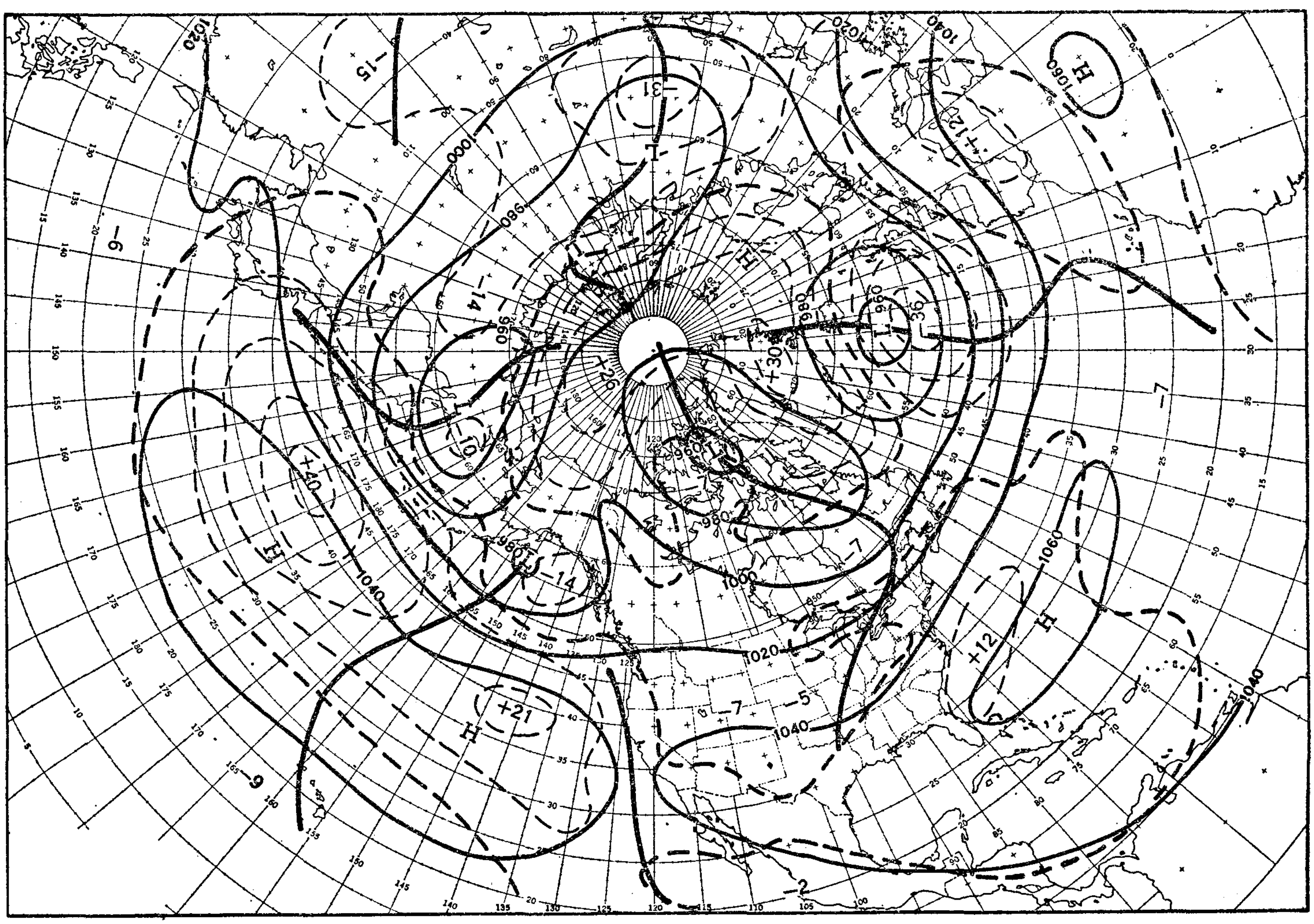


FIGURE 1.—Mean 700-mb. chart for the 30-day period July 1–30, 1950. Contours at 200-foot intervals are shown by solid lines, 700-mb. height departures from normal at 100-foot intervals by dashed lines with the zero isopleth heavier. Anomaly centers and contours are labeled in tens of feet. Minimum latitude trough locations are shown by heavy solid lines.

result cyclonic curvature prevailed in the circulation over the central part of the United States, where the warm High and subsidence aloft typical of the dust-bowl decade of the 1930's were conspicuous by their absence. Frequent showers and thunderstorms were favored by horizontal convergence, upward vertical motion, and instability in the vicinity of the trough, while daytime maximum temperatures were kept low by the large amount of associated cloudiness. Thus comparison of figure 1 with Charts I, IV, and V (inset) reveals in general a good agreement between the areas of cyclonic curvature and negative height anomaly at 700 mb. and the regions of much cloudiness, sub-normal temperature, and above-normal precipitation at the surface. Cloudiness and showers were also favored by large-scale convergence in a sharp inverted trough in the 1014-mb. mean isobar at sea level (Chart VI) in the central and southern Plains. In addition, large quantities of moisture were carried into this region from the Gulf of Mexico since sea level winds were more southeasterly than normal (Chart II inset).

The weather of the United States was also related to features of the general circulation farther afield. It can be seen in figure 1 that the 700-mb. westerlies in the eastern Pacific, between a Low center in the Gulf of Alaska and a High center almost directly to the south, were considerably stronger than normal. Likewise the westerlies in eastern North America and the Atlantic were stronger than normal. As a result the zonal index at 700 mb., measured between latitudes 35° N. and 55° N. from 0° westward to 180°, was more than 2 m/sec higher than normal, and the strength of the mean jet stream at 700 mb. for July 1950 in the Western Hemisphere exceeded the normal by as much as 3 m/sec (fig. 2). This jet was centered between 45° N. and 50° N. in the hemisphere as a whole, but was weaker and farther south in the United States proper. Consequently during the month five distinct frontal systems entered the Pacific Northwest, dropped southward and intensified east of the Divide,

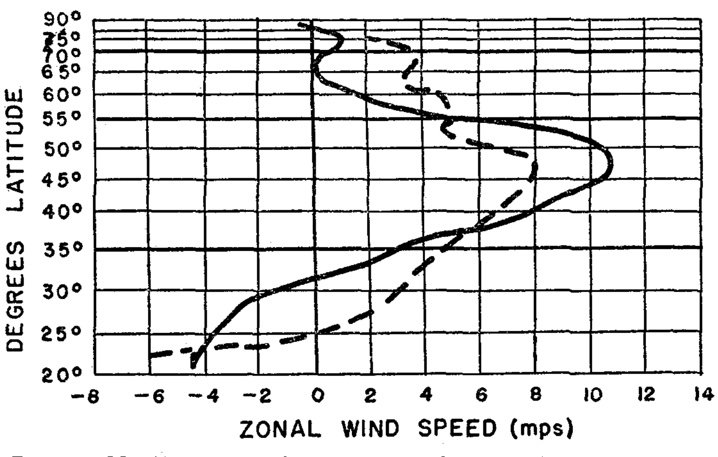


FIGURE 2.—Monthly mean 700-mb. geostrophic zonal wind speed profile in meters per second averaged from 0° westward to 180° longitude. Solid curve is for July 1950, dashed line is July normal.

and continued east-northeastward across the country into the Atlantic. Each was accompanied by widespread cloudiness and showers and followed by a surge of high pressure and cool maritime air from the north Pacific. These are not indicated in Charts II and III, however, because their continuity was obscured in the mountains of western North America due to the absence of a closed circulation.

After crossing the Continental Divide, these surges of cool Pacific air were reinforced by outbreaks of cool polar continental air from the Hudson Bay region. These outbreaks accompanied the movement of several anticyclones, from central Canada through the Dakotas, Minnesota, and the Lakes along tracks given in Chart II. Southward movement of cool Canadian air into the United States was facilitated by the fact that pressures relative to normal were generally higher in Canada than in the central United States. This was a type of blocking action which showed up at 700 mb. (fig. 1) as a westward protrusion of a strong positive height anomaly center over Greenland into northeastern Canada, while heights in southern Canada and the central United States were generally below normal. At sea level, monthly mean pressures were above normal in practically all of Canada, with the greatest departure, +3 mb., in central Hudson Bay (chart not shown), whereas in the United States lesser positive or negative pressure anomalies were found (Chart II inset). The thickness of the air column between sea level, where pressures were above normal, and 700 mb., where heights were below normal, was therefore below normal in most of central and southern Canada. This meant that the source region for polar continental air entering the United States was unusually cool, a favorable condition for below-normal surface temperatures.

In eastern and southeastern sections of the country generally cool, wet weather occurred with anticyclonic curvature and above-normal heights at 700 mb. Moreover, the Bermuda High was well developed and west of its normal position both at sea level and at 700 mb., a condition generally associated with warm weather in the eastern United States. This discrepancy can be attributed to the presence of a trough just west of the Appalachians in the fields of both the departure of monthly mean sea level pressure from normal (Chart II inset) and the mean isotherms at 700 mb. (Chart IX). These troughs probably furnished the convergence and instability necessary to release large amounts of moisture, transported by stronger-than-normal southwesterly flow at 700 mb. (fig. 1), with frequent showers, abundant cloudiness, and cool surface temperatures as a consequence. The displacement of the isotherm trough well to the east of the contour trough at 700 mb. in this area is a very unusual circumstance since contours and isotherms are nearly in phase on most monthly mean maps at upper levels. As a consequence the contour trough sloped to the east with increasing elevation, at least from 700 to 300 mb., (compare Charts IX, X, and XI), temperatures at 700 mb. were below normal where heights were above normal in the Southeast, and the Bermuda High was cold and therefore quite weak in the upper troposphere. This anomalous nature of the Bermuda High is difficult to explain, but it probably contributed toward making this a generally cool, rainy July in the eastern United States.

The principal exceptions to the cool, wet regime east of the Divide were southeast Texas and portions of the Northeast. Chart I shows that temperatures were slightly above normal in coastal sections of New England and the Middle Atlantic States, and also in parts of New York, New Hampshire, and Vermont, while precipitation was generally deficient in these areas (Chart V inset) as well as in portions of Pennsylvania and Maryland. At Portland, Maine total precipitation for the month was less than half of the normal amount and only .01 inch more than the driest of record. This relatively warm, dry condition in the Northeast was associated with the fact that 700-mb. heights were above normal (fig. 1) and airflow at both sea level and 700 mb. was more westerly (and therefore more downslope) than normal (Chart II inset and Chart VI). The warm, dry weather experienced in southeast Texas was also associated with positive departures from normal of local 700-mb. height. In addition, review of the daily weather maps indicates the presence of a quasi-stationary polar front, oriented from northeast to southwest, across central Texas during a good deal of the month. Although it is difficult to detect this mean frontal zone on any of the monthly mean maps, it was primarily responsible for temperatures that were 3° above normal at Corpus Christi, but more than 2° below normal at Waco, only 200 miles to the north.

The fields of monthly mean sea level pressure (Chart VI) and its departure from normal (Chart II inset) show that southeasterly winds (see wind roses, Chart I) were stronger than normal throughout Florida. As a result cool ocean breezes caused below normal temperatures in most of the State. The greatest departure occurred at Miami, where the temperature averaged 1.9° below normal, the coolest July on record. On the west coast of Florida, however, temperatures were generally above normal as the easterly gradient flow weakened the normal westerly sea breeze. This probably resulted in a westward displacement of the sea breeze convergence zone normally found in the interior of the peninsula. Showers associated with this convergence zone produced nearly 14 inches of rainfall at Tampa, on the west coast, but directly across the peninsula at Melbourne, on the east coast, only 4 inches fell (Chart V).

As frequently happens, the weather west of the Rocky Mountain States was of quite a different character than that to the east. Chart I shows that temperatures were predominantly above the seasonal normal in Washington, Oregon, California, Nevada, and Arizona, with the greatest departure, 4.8°, at Red Bluff, Calif. This abnormal surface warmth was intimately related to the existence of a well-developed thermal low at sea level (Chart VI), in the center of which pressures were as much as 3 mb. below normal (Chart II inset), and to strong anticyclonic vorticity at 700 mb. (fig. 1). In addition airflow was more northeasterly than normal at sea level and northerly relative to normal at 700 mb., so that warming was favored by downslope winds and by abundant insolation (Chart IV). In coastal sections of northern California, Oregon, and Washington, on the other hand, temperatures averaged slightly below normal because of the predominance of strong sea breezes (see wind roses, Chart I) and stratus cloud conditions (Chart IV), induced by abnormal warmth in the interior valleys.

It is perhaps surprising that total rainfall during the month exceeded the normal amount throughout the southern half of California and most of Nevada, Utah, and Arizona since dry weather usually goes with the warm conditions described in the preceding paragraph. However, nearly all of this rain fell in a few days, from July 5 to 10, when a strong southeasterly circulation both at sea level and aloft, accompanying a tropical cyclone near the southern tip of the Lower California peninsula, transported moist maritime tropical air from the Gulf of Mexico across the mountains to the Coast of California. Although this circulation was not sufficiently persistent or recurrent to show up on the mean maps for the month, it produced sufficiently heavy showers in a few days to exceed the extremely low totals of rainfall normally observed in a month in the southwest desert area. Gulf moisture was not able to penetrate into northern California, Oregon, and Idaho, where precipitation was generally deficient as dry northeasterly flow at the surface and anticyclonic curvature aloft prevailed. Pacific moisture and frequent frontal passages produced excessive rainfall in western Washington due to the presence of stronger westerlies than normal at 700 mb. from the Gulf of Alaska southward, as described earlier.

It is interesting to note that over most of the United States the temperature regime during July 1950 was a complete reversal from that of the preceding month (compare Charts I of June and July, Monthly Weather Review). In June surface temperatures were mostly above normal east of the Continental Divide, and below normal to the west, just the opposite of conditions in July. An equally contrasting pattern was evident in the 700-mb. circulation (see fig. 1 of article by Aubert in Monthly Weather Review, June 1950). In June eastern and central portions of the United States were dominated by anticyclonic curvature and above normal heights at 700 mb., while the western third of the country was under the influence of a well-developed mean trough, just the opposite of the 700-mb. pattern in July.

Chart I. Departure (°F.) of the Mean Temperature from the Normal, and Wind Roses for Selected Stations, July 1950

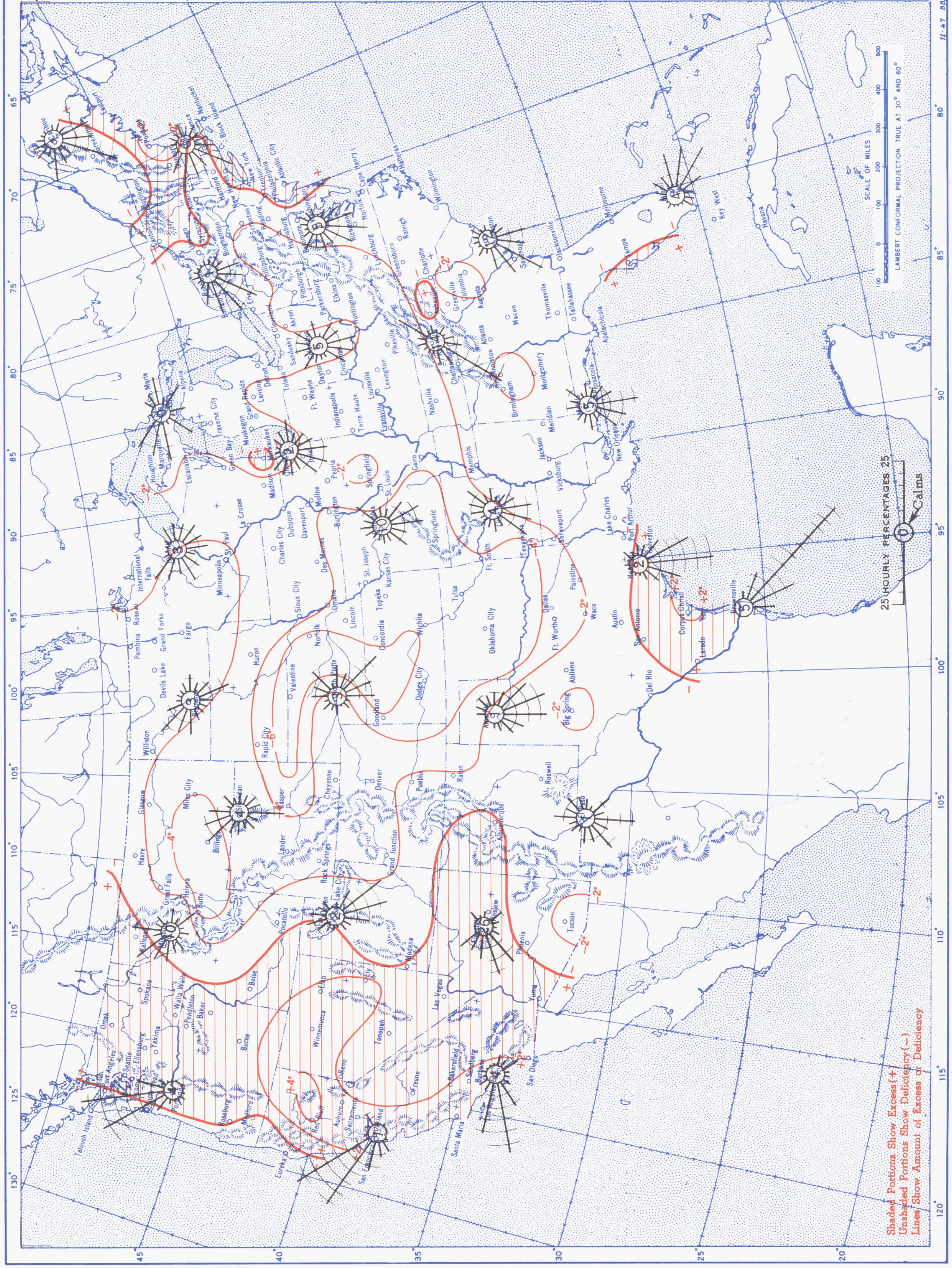
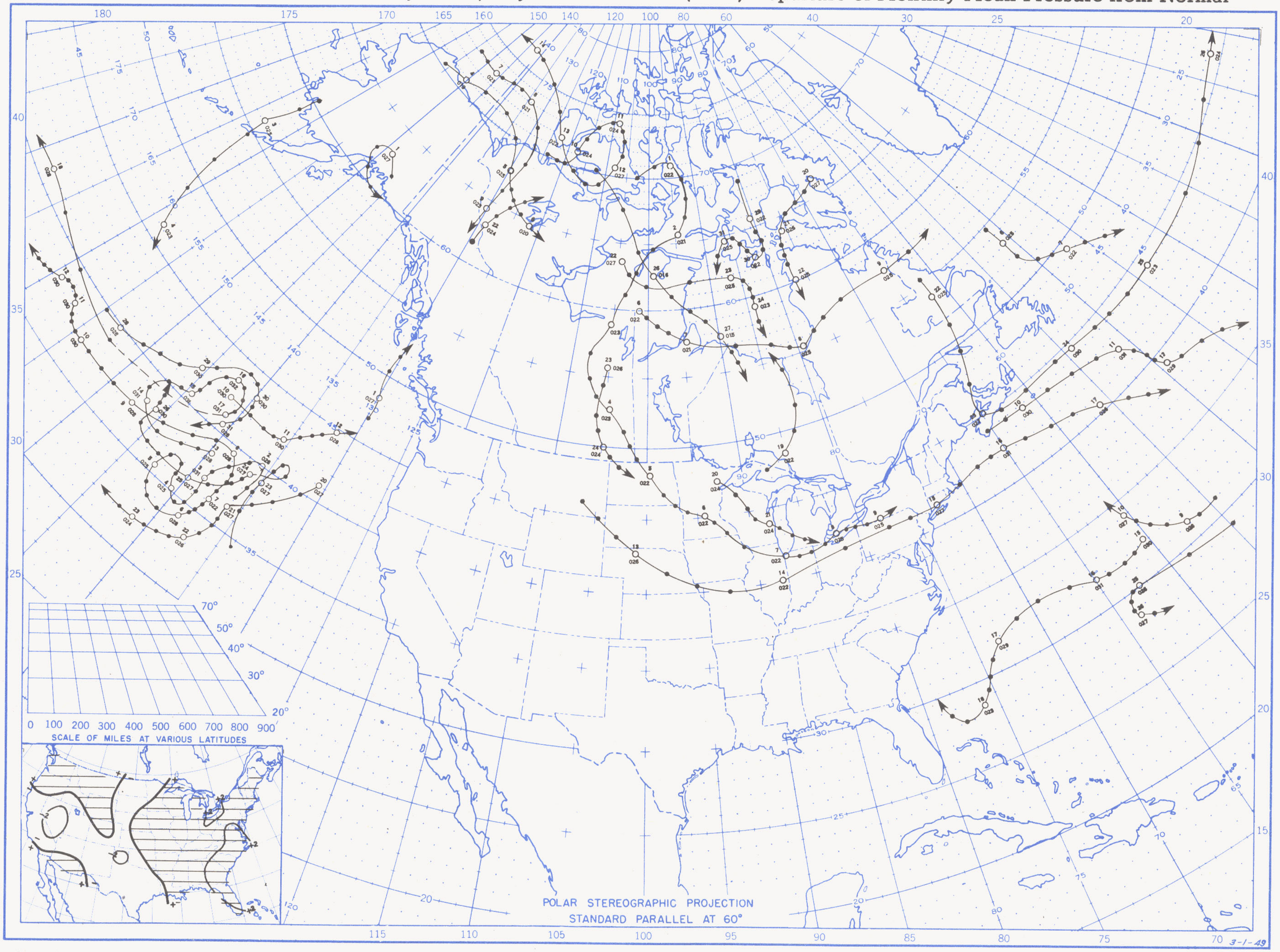
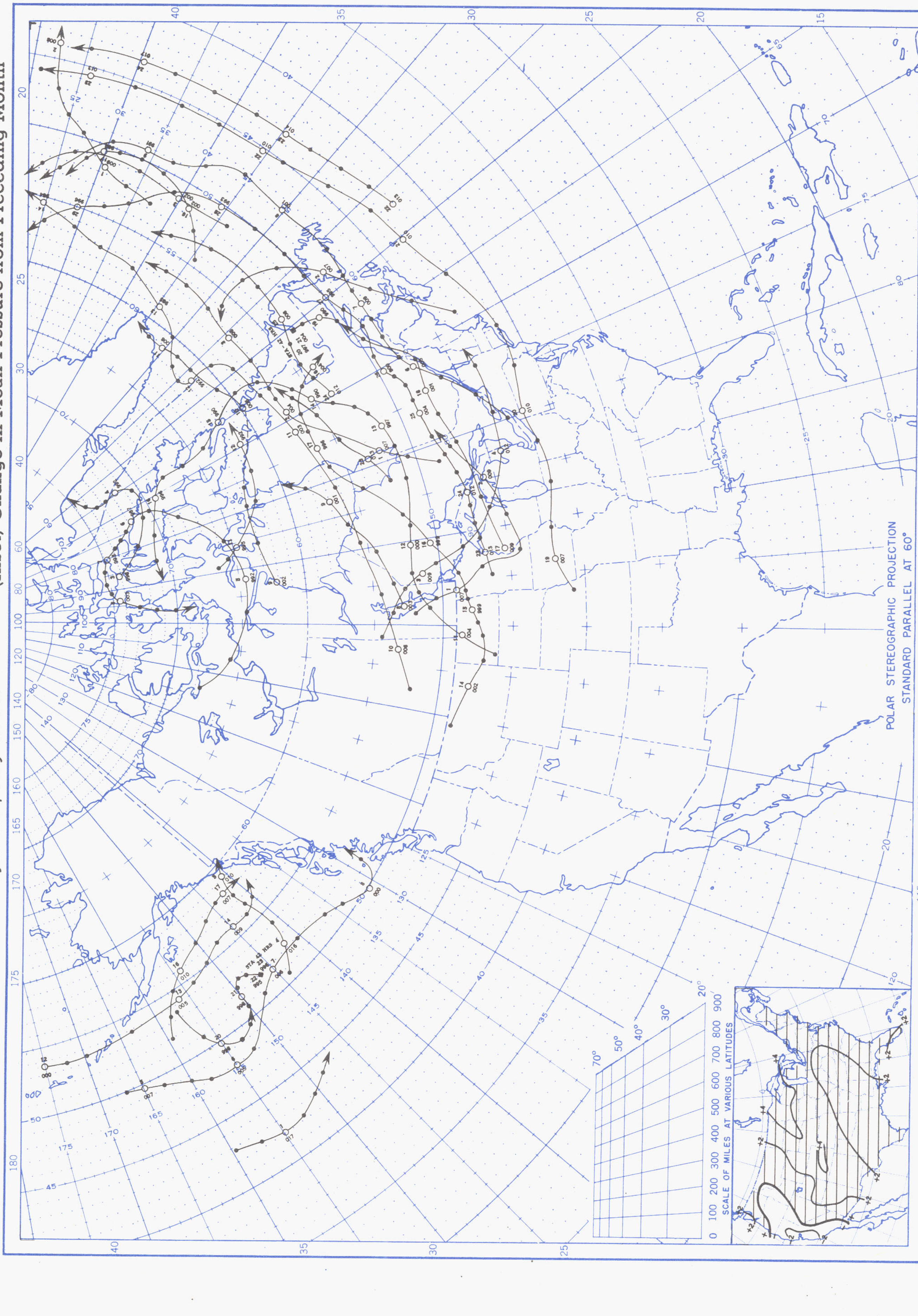


Chart II. Tracks of Centers of Anticyclones, July 1950. (Inset) Departure of Monthly Mean Pressure from Normal



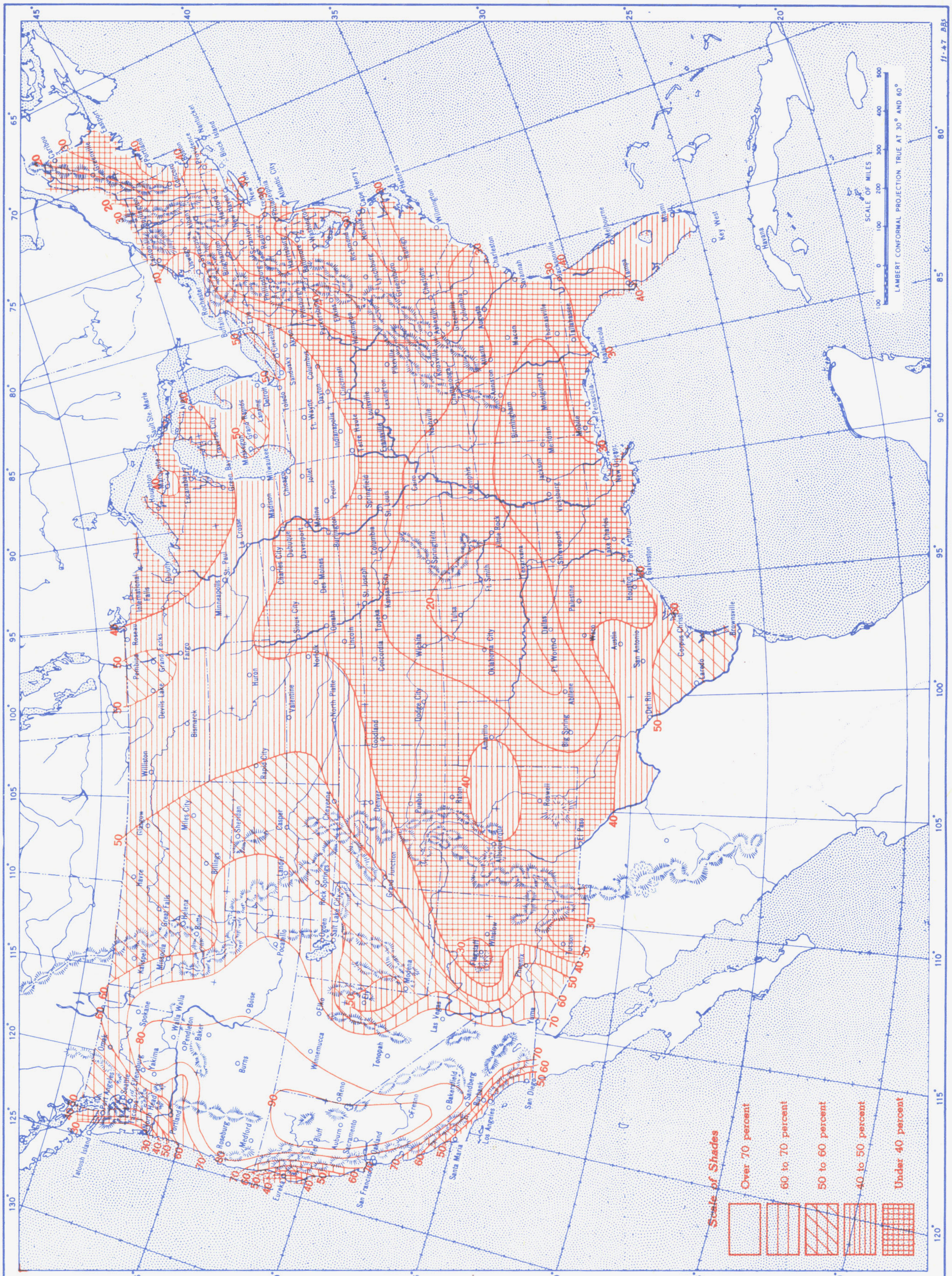
Circle indicates position of anticyclone at 7:30 a. m. (75th meridian time). Dots indicate intervening 6-hourly positions. Figure above circle indicates date, and figure below, pressure to nearest millibar. Only those centers which could be identified for 24 hours or more are included.

Chart III. Tracks of Centers of Cyclones, July 1950. (Inset) Change in Mean Pressure from Preceding Month



Circle indicates position of cyclone at 7:30 a. m. (75th meridian time) Dots indicate intervening 6-hourly positions. Figure above circle indicates date, and figure below, pressure to nearest millibar. Only those centers which could be identified for 24 hours or more are included.

Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, July 1950



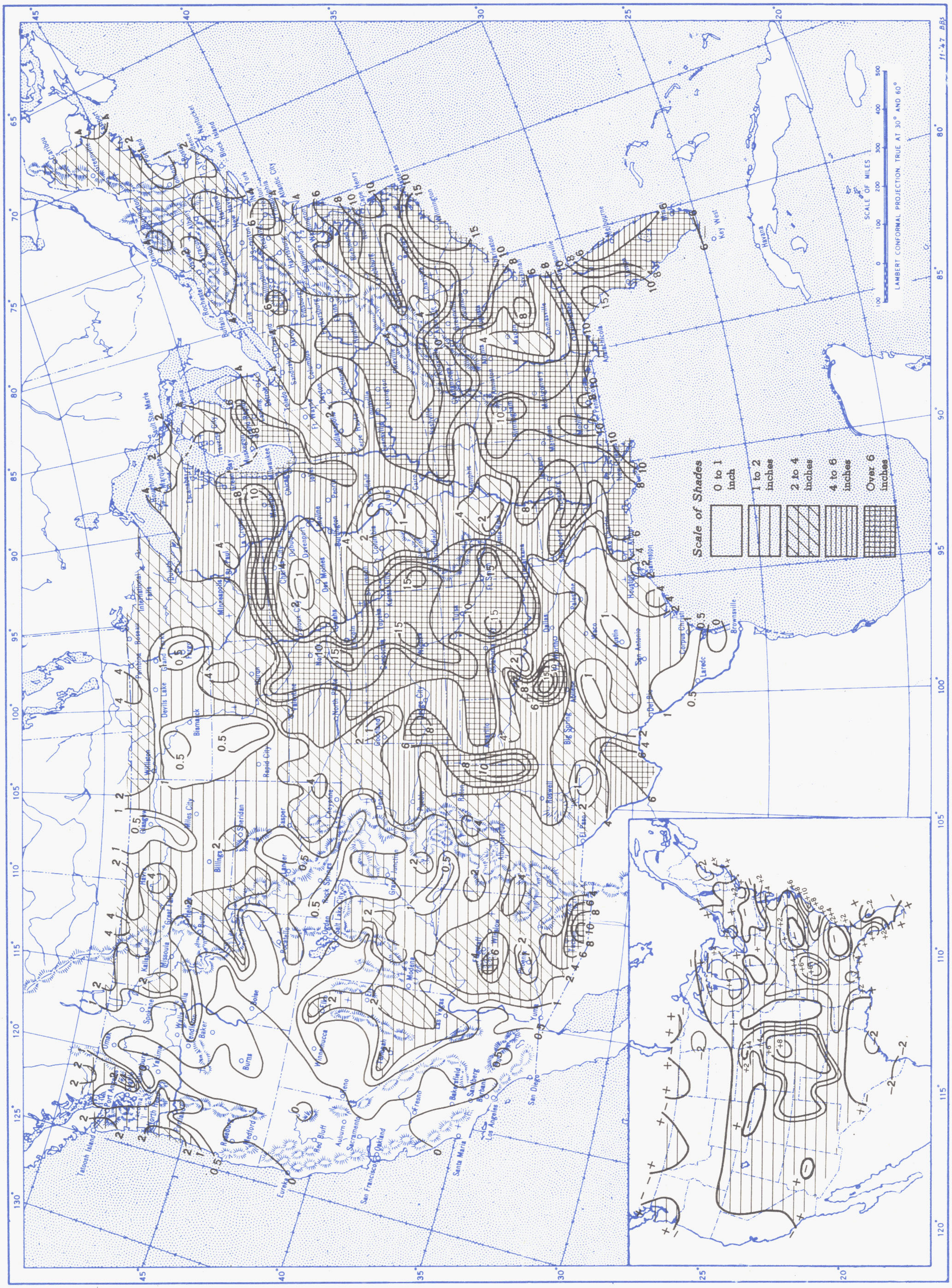
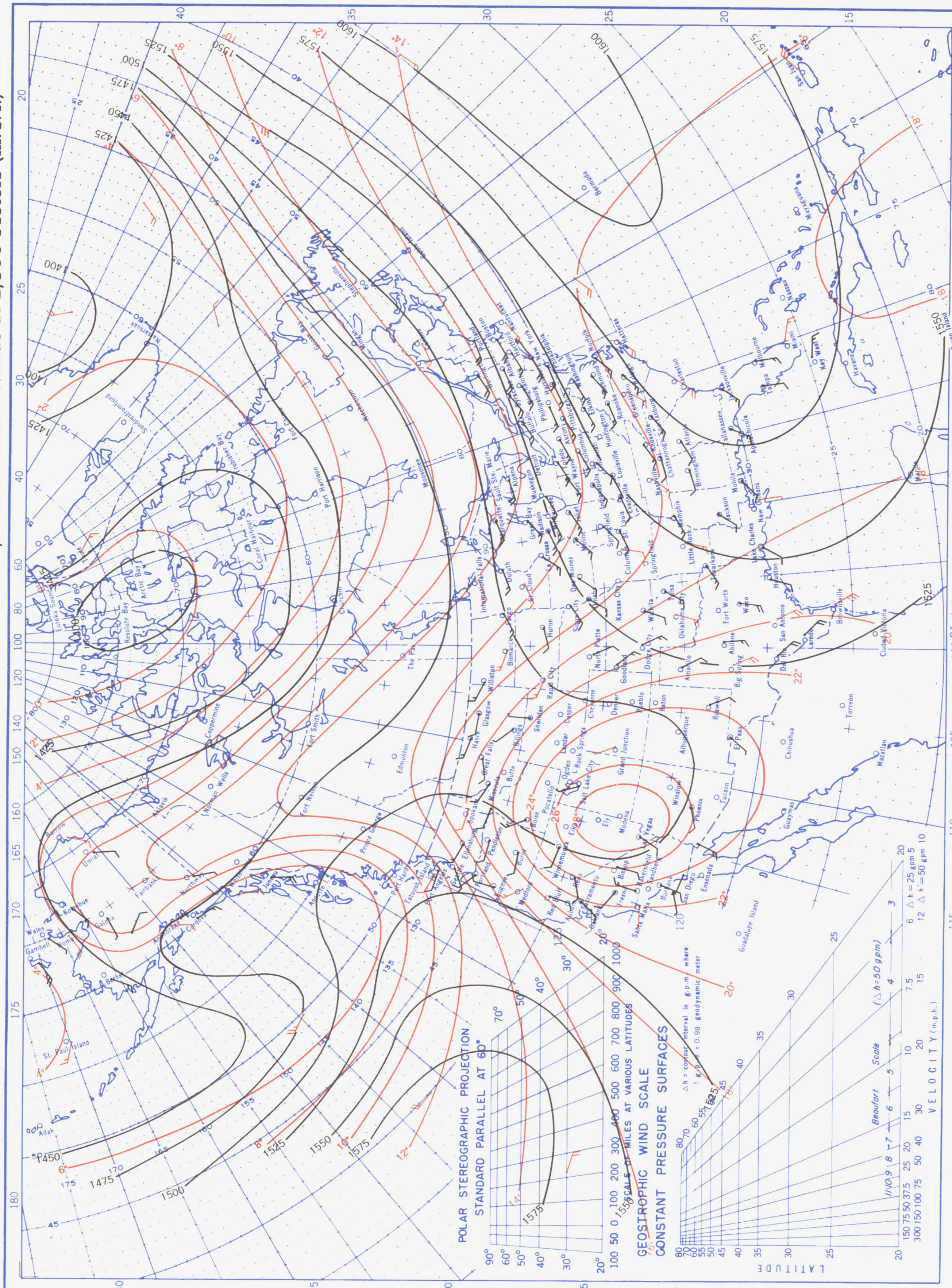


Chart V. Total Precipitation, Inches, July 1950. (Inset) Departure of Precipitation from Normal

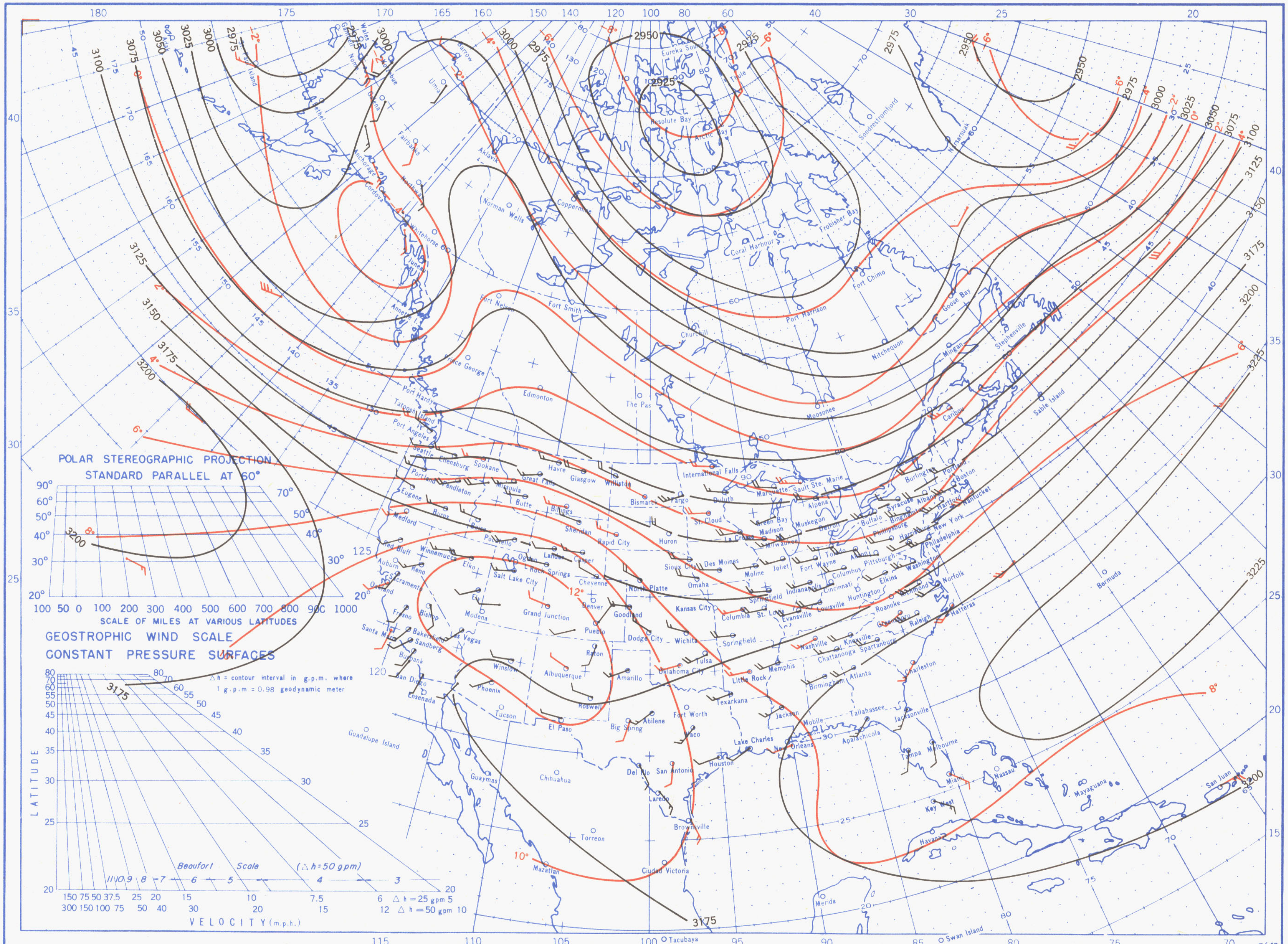
Chart VI. Mean Isobars (mb.) at Sea Level and Mean Isotherms (°F.) at Surface, July 1950

Chart VIII, July 1950. Contour Lines of Mean Dynamic Height (Geopotential) in Units of 0.98 Dynamic Meters and Mean Isotherms in Degrees Centigrade for the 850-millibar Pressure Surface, and Resultant Winds at 1,500 Meters (m. s. l.)



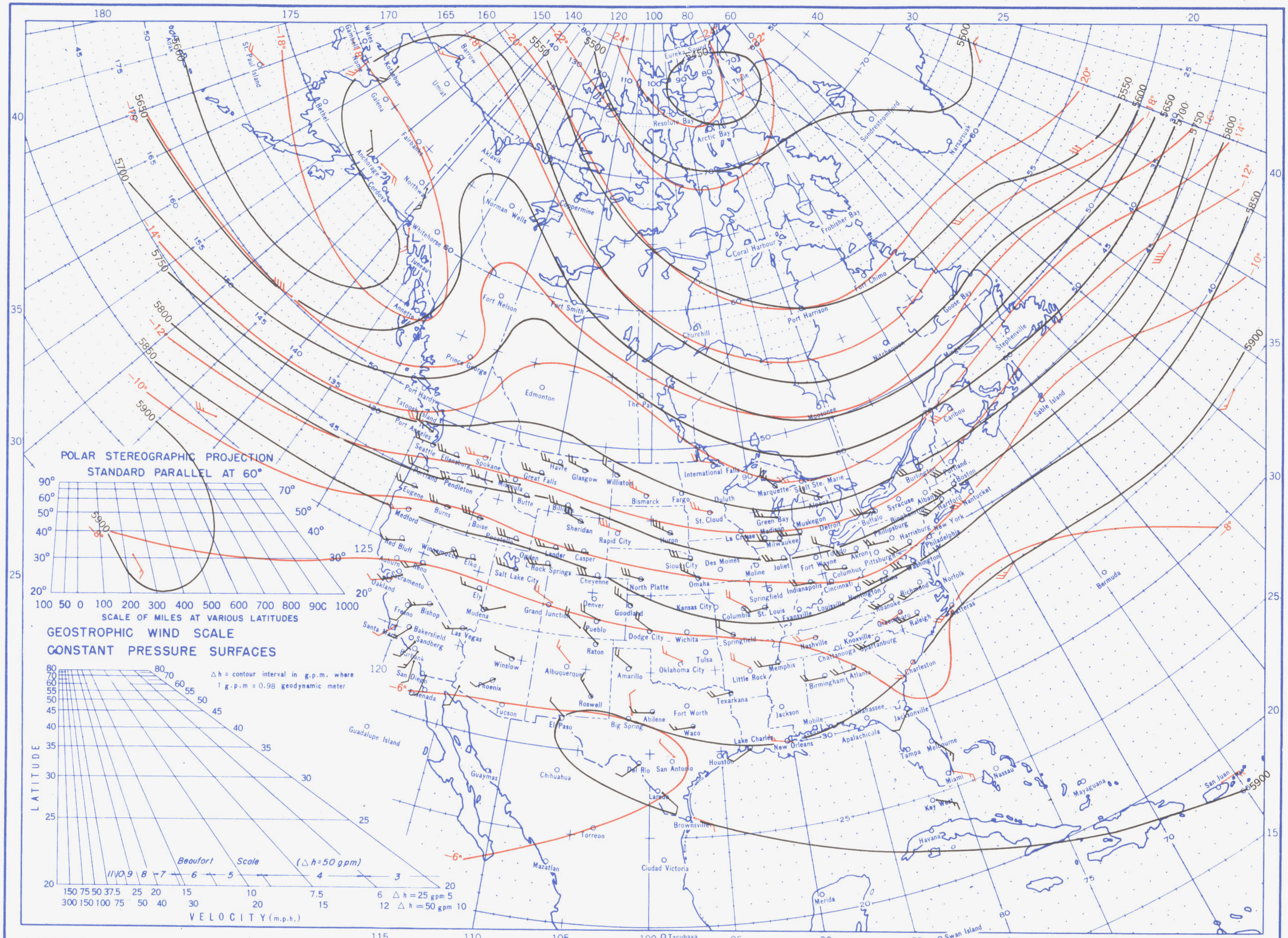
Contour lines and isotherms based on radiosonde observations at 0300 G. C. T. Winds indicated by black arrows based on pilot balloon observations at 2100 G. C. T.; those indicated by red arrows based on rawins taken at 0300 G. C. T.

Chart IX, July 1950. Contour Lines of Mean Dynamic Height (Geopotential) in Units of 0.98 Dynamic Meters and Mean Isotherms in Degrees Centigrade for the 700-millibar Pressure Surface, and Resultant Winds at 3,000 Meters (m. s. l.)



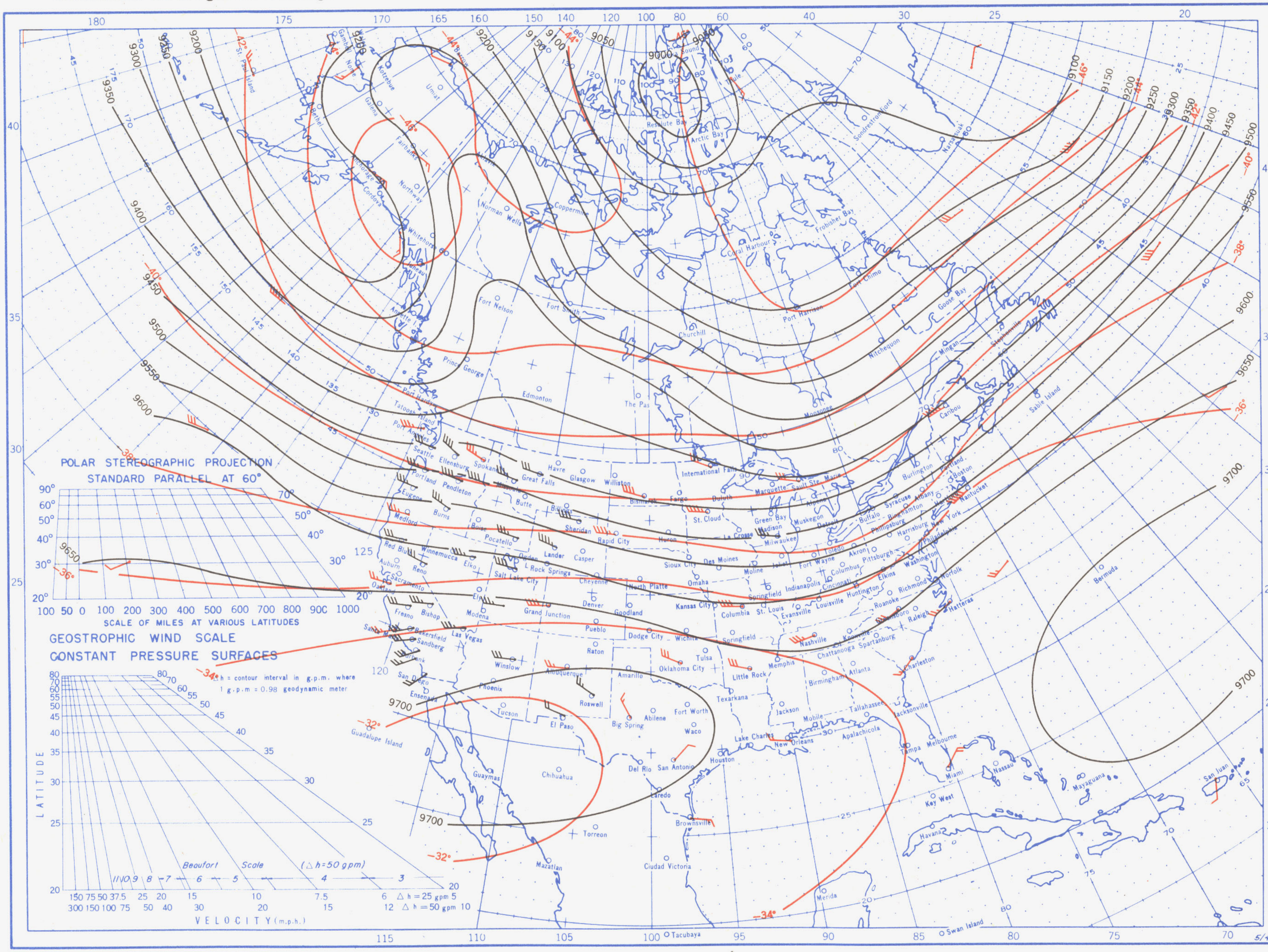
Contour lines and isotherms based on radiosonde observations at 0300 G. C. T. Winds indicated by black arrows based on pilot balloon observations at 2100 G. C. T.; those indicated by red arrows based on rawins taken at 0300 G. C. T.

Chart X, July 1950. Contour Lines of Mean Dynamic Height (Geopotential) in Units of 0.98 Dynamic Meters and Mean Isotherms in Degrees Centigrade for the 500-millibar Pressure Surface, and Resultant Winds at 5,000 Meters (m. s. l.)



Contour lines and isotherms based on radiosonde observations at 0300 G. C. T. Winds indicated by black arrows based on pilot balloon observations at 2100 G. C. T.; those indicated by red arrows based on rawins taken at 0300 G. C. T.

Chart XI, July 1950. Contour Lines of Mean Dynamic Height (Geopotential) in Units of 0.98 Dynamic Meters and Mean Isotherms in Degrees Centigrade for the 300-millibar Pressure Surface, and Resultant Winds at 10,000 Meters (m. s. l.)



Contour lines and isotherms based on radiosonde observations at 0300 G. C. T. Winds indicated by black arrows based on pilot balloon observations at 2100 G. C. T.; those indicated by red arrows based on rawins taken at 0300 G. C. T.